Remarks

Thorough examination by the Examiner is noted and appreciated.

Support for the amended claims is found in the previously presented claims, the Specification and the Figures.

No new matter has been added.

For example support for the amendments and new claims is found in the original and previously presented claims as well as the Figures including Figure 1E, and the Specification:

0023 Referring to Figure 1C, following formation of an inorganic or organic ARC layer 24B one or more resist layers e.g., 26 is deposited and patterned. The resist layer 26 may be a single or multiple layer resist including organic and inorganic materials, for example a lower organic rest layer and an overlying resist including silicon incorporated by a silylation process or including silicon monomers. The resist layer e.g., 26 may have a total thickness of about 0.1 microns to about 1.0 microns, and is preferably sensitive to wavelengths less than about 400 nm. A lithographic patterning process is carried out including radiation exposure and development by appropriate wet or dry development processes, followed by conventional dry etching processes to etch through the first ILD layer 22A to form a first set of contact openings e.g., 28A, 28B, 28C, 28D, and 28E. **The contact openings may be formed in the shape of an oval (circular), butt contact, rectangular (e.g., square), or combinations thereof.** For example, the contact openings may include a local interconnect opening, e.g., 28C, having the preferred aspect ratio at a lowermost (bottom) portion of the contact opening.

Claim Rejections under 35 USC 103

1. Claims 18-22, 24, 25, 27-30, 32-35, and 38-45, 47, 49 and 50 stand rejected under 35 USC Section 103(a) as being unpatentable over Tamaru (US 2003/0030146) in view of Chen et al. (6,784,096).

Tamaru disclose a **single contact layer** (16) with contact interconnect structures (18; e.g., Figures 6, 7) penetrating the single contact layer (16). Tamaru clearly disclose forming **contact holes (openings)** (17) in the single contact layer (16) and forming metal W plugs (18) (TiN barrier layer and W metal plug in the contact holes (paragraph 0079). Tamaru then disclose forming **wiring grooves (lines)** for forming **first layer Cu wiring** (24) (also known in the art to one of ordinary skill as a **metallization layer** (as **opposed to contacts or contact opening in a contact layer**) including a "**high melting metal nitride**" **barrier layer** (TiN, Ti/TiN, WN, TaN, and Ta/TaN paragraph 0088) separating the **contact metal plugs** and the **Cu wiring in the metallization layer above the contact layer** (16) (see paragraphs 0080, 0087, 0088; Figures 6 and 7). Thus, in cross section the Cu **wiring** (24) makes physical contact with the "**high melting metal nitride**" **barrier layer on the contact interconnect**

structure i.e., barrier layer on contact **plugs (metal filled holes)** (18) and (see also Abstract and claim 1).

Therefore Tamaru fails to disclose Applicants invention including those elements in **bold type**:
With respect to claim 18:

"A **contact interconnect structure** comprising:

a semiconductor substrate comprising CMOS devices including active contact regions;

a first contact layer overlying the active contact regions comprising a first plurality of metal filled contact openings extending through the first contact layer thickness to the active contact regions;

a second contact layer overlying the first contact layer comprising a second plurality of metal filled contact openings, each of said second plurality of metal filled contact openings extending through the second contact layer thickness to physically contact a major metal filling portion of a respective

one or more of the first plurality of metal contact filled openings;

wherein, the first plurality and the second plurality of metal filled contact openings **form a physically continuous contact interconnect structure,** said first and second metal filled contact openings having an aspect ratio of less than about 4.5 with respect to a respective contact layer, **said contact interconnect structure connecting said active contact regions to overlying wiring circuitry comprising metallization layers, wherein said first and second metal filled contact openings do not comprise wiring grooves, but comprise contact holes.**"

With respect to claim 32:

36. A contact interconnect structure comprising:

at least first and second stacked contact layers comprising a respective first and second plurality of metal filled contact openings, extending through ~~the~~ respective first and second contact layers, each of said second plurality of metal filled contact openings extending to a respective contact region

comprising an active transistor region, **each of said first plurality of metal filled contact openings physically contacting a respective one of said second plurality of metal filled contact openings, said physical contact through major metal filling portions comprising said first and second plurality of metal filled contact openings;**

wherein, the first plurality and the second plurality of metal filled contact openings comprise a bottom portion having a maximum width of less than about 70 nanometers, said first and second metal filled contact openings having an aspect ratio of less than about 3.3 with respect to a respective contact layer, **said first and second plurality of said metal filled contact openings connecting said active contact regions to overlying wiring circuitry** comprising metallization layers, **wherein said first and second metal filled contact openings do not comprise wiring grooves, but comprise contact holes**.

Examiner is apparently erroneously (and contrary to the understanding of the structures and plain meaning of Applicants claim language to one of ordinary skill (as is evidenced by the teachings of Tamaru) equating the metallization layer (**including**

wiring grooves) of Tamaru as equivalent to Applicants second contact layer (including the second metal filled contact openings).

In response to Applicants attempt to explicitly define Applicants two contact layers each including metal filled contact openings (or contacts) over the clear teachings of Tamaru (**a metal wiring layer including wiring grooves overlying a single contact layer**)"Applicants explicitly excluded wiring groves i.e., , said first and second metal filled contact openings not comprising wiring grooves". In response Examiner states that with respect to the disclosure of Tamaru "one may regard them as "not wiring grooves insofar as this language is supported".

Applicants respectfully note this appears to be directly contrary to the clear language of Tamaru in referring to wiring 24 formed in a wiring groove 22 over a first **contact layer**: e.g.

[0079] Next, as shown in FIG. 4, a silicon nitride film 15 and a silicon nitride film 16 are deposited over the substrate 1 by a CVD method, and the silicon oxide film 16 and the silicon nitride film 15, respectively, formed over the n.sup.+-type semiconductor regions 11 (source, drain) and the p.sup.+-type semiconductor regions 12 (source, drain) are dry-etched **to form contact holes**

17, followed by **forming a metal plug 18 in the inside of each contact hole 17**. For the etching of the silicon oxide film 16, a hydrofluorocarbon gas or a fluorocarbon gas such as CF.sub.4, CHF.sub.3, C.sub.4F.sub.8 or the like is used so as to reduce the etching rate of the lower silicon nitride film 15. When the silicon nitride film 15 is etched, a mixed gas of oxygen and Ar added to a hydrofluorocarbon gas (CHF.sub.3, CH.sub.2F.sub.2 or the like) is used. For the formation of the metal plug 18, a TiN (titanium nitride) film and a W (tungsten) film are deposited over the silicon oxide film 16 including the inside of the contact hole 17 by a CVD method, and the unnecessary portions of the TiN film and the W film on the silicon oxide film 16 are removed by a chemical mechanical polishing (CMP) method or an etch back method. It will be noted that the silicon oxide film 16 may be formed not only of a silicon oxide film formed by an ordinary CVD method using monosilane (SiH.sub.4) as a source gas, but also of a BPSG (boron-doped phosphosilicate glass) film, an SOG (spin on glass) film formed by a spin coating method, or a builtup film thereof.

[0087] Next, after removal of the photoresist film 50, **a first-layer Cu wiring 24 is formed in the wiring groove 22 as shown in FIG. 7**. The Cu wiring 24 is constituted of a builtup film of a barrier metal film and a Cu film and formed in the following way. Initially, a barrier metal film and a Cu film are, respectively, deposited over the silicon oxynitride film 21 including the inner portion of the wiring groove 22, followed by thermal treatment (reflow) in a non-oxidative atmosphere (e.g. in an atmosphere of hydrogen) **to compactly bury the Cu film in the inside of the wiring groove 22**. Thereafter, unnecessary portions of the Cu film and the barrier metal film outside of the wiring groove 22 are removed by a chemical mechanical polishing method. For the polishing of the Cu film and the barrier metal film, a polishing slurry, which is obtained, for example, by dispersing or dissolving, in water, main component of a grain such as of alumina and an oxidizing agent such as an aqueous hydrogen peroxide solution or an aqueous ferric nitrate solution, is used.

Examiner has cited no support for his position that Applicants claim language **explicitly excluding wiring grooves may**

simply be ignored, or explained why he is interpreting Applicants claim language contrary to what one of ordinary skill in the art would understand **contact layers, contact openings and contact holes** to mean, including in the disclosure of Tamaru itself.

It is further respectfully noted that Examiner's explanation for interpreting Applicants claim language and prior art is not understandable to Applicants.

For example, Examiner states in "Response to Arguments" "Neither the claim language not the record precludes reading the claims onto the structure of Tamaru. Tamaru may be regarded as disclosing metal filled contact openings which are not wiring grooves insomuch as the instant application, though a metal opening could also be called wiring".

Applicants respectfully note that such statement is not understandable. Applicants respectfully request a clear explanation of Examiners reasoning and support for his reasoning in the MPEP. Applicants respectfully request and explanation of how it is that Applicants claim language including readily understandable terms of art including contact layers, contact

openings and contact holes may be interpreted contrary to the understanding of one of ordinary skill in the art as well as ignoring Applicants claim language that **explicitly excludes wiring grooves not in a contact layer** of the prior art (Tamaru).

Applicants have nevertheless further amended their claims in a further effort to clearly and unambiguously define over the prior art, and have included the reference "Semiconductor Manufacturing Technology", M. Quirk, J. Serda, Prentice Hall, 2001, as further evidence of how one of ordinary skill in the art would interpret Applicants claim language including a **contact** structure, which includes the Applicants **contact** layers, **contact** openings and **contact** holes. For example, "contact" is defined as "an electrical connection at the silicon surface between the devices in the silicon wafer and the first metal layer".

See e.g., MPEP 2111.01:

> During examination, the claims must be interpreted as broadly as their terms reasonably allow. **This means that the words of the claim must be given their plain meaning** unless applicant has provided a clear definition in the specification. *In re Zletz*, 893 F.2d 319, 321, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989).
>
> **When not defined by applicant in the specification, the words of a claim must be given their plain meaning. In other words, they must be read as they would**

be interpreted by those of ordinary skill in the art. *In re Sneed,* 710 F.2d 1544, 218 USPQ 385 (Fed. Cir. 1983).

Moreover, as noted above, Tamaru nowhere discloses or suggests that the Cu filled wiring grooves **physically contact** a major metal filling portion of the metal filled (W) contact plugs (i.e., tungsten). Rather Tamaru clearly disclose **a metal nitride barrier layer between the two major metal filling portions of the structures** (see paragraphs 0080, 0087, 0088; Figures 6 and 7).

In contrast to Tamaru, and in **non-analogous art,** Chen et al. disclose a method of **forming a barrier layer to line vias** where the **vias** are disclosed to have a width less than 70 nm or an aspect ratio greater than about 3:1 (see Abstract; Figures).

"Embodiments of the present invention provide **methods and apparatus for forming barrier layers in high aspect ratio vias (e.g., vias having aspect ratios of 3:1, 4:1, 5:1 or higher)** and/or **vias having via widths of about 0.065-0.2 microns or below**. It will be understood that the invention also may be employed to form barrier layers in lower aspect ratio and/or wider vias. Each embodiment allows a relatively thick barrier layer to be deposited on the sidewalls of a via with little or no barrier layer coverage on the bottom of the via. Adequate diffusion resistance and/or mechanical strength thereby may be provided without significantly increasing the contact resistance of the interconnect formed with the via."

Even assuming *arguendo,* a proper motivation to modify Tamaru

based on the teachings of Chen et al., such modification **fails to produce Applicants invention.**

Moreover, modification of the wiring grooves of Tamaru by the vias of Chen et al. in an effort to produce Applicants invention would **change the principle of operation** of the wiring grooves of Tamaru (acting as wiring in a metallization layer overlying a contact layer) and make the device of Tamaru **unsatisfactory for its intended purpose** (having wiring in a metallization layer overlying a contact layer).

See MPEP 2143.01.

THE PROPOSED MODIFICATION CANNOT RENDER THE PRIOR ART UNSATISFACTORY FOR ITS INTENDED PURPOSE

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

THE PROPOSED MODIFICATION CANNOT CHANGE THE PRINCIPLE OF OPERATION OF A REFERENCE

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

Further, as noted above, Tamaru nowhere discloses metal filled contact openings not comprising wiring grooves, but comprising holes, **physically contacting one another** but rather discloses **Cu filled wiring grooves** in a metallization layer contacting a **metal nitride barrier layer** formed **between** contact openings (plugs) and the **Cu filled wiring grooves**.

"**First**, there must be some **suggestion or motivation**, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. **Second**, there must be a **reasonable expectation of success**. **Finally**, the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).*

"The prior art must provide a motivation or reason for the worker in the art, without the benefit of appellant's specification, to make the necessary changes in the reference device." *Ex parte Chicago Rawhide Mfg. Co., 223 USPQ 351, 353*

(Bd. Pat. App. & Inter. 1984).

With respect to claims 47, and 49 Examiner is mistaken that Tamaru discloses "The contact interconnect structure of claim 38, wherein the first plurality and the second plurality of metal filled contact openings comprise the same material."

Rather, as noted above, Tamaru discloses **Cu filled wring grooves** 24 overlying and contacting a barrier layer overlying metal filled plugs (holes) and nowhere discloses second Cu metal filled contact openings (holes) overlying and contacting first Cu metal filled contact openings (holes).

2. Claims 26 and 36 stand rejected under 35 USC Section 103(a) as being unpatentable over Tamura, above in view of Chen et al., above, and further in view of Ono (IEE Trans on Electronic Devices, pg 1822 Vol. 42, No. 10, 1995).

Applicants reiterate the comments made above with respect to Tamura and Chen et al.

Even assuming *arguendo*, a proper motivation to further

modify Tamura with the teachings of Ono, the further fact that Ono discloses a gate length of less than about 45 nm without a corresponding disclosure or teaching of a contact interconnect structure does not further help Examiner in producing Applicants invention.

"**First**, there must be some **suggestion or motivation**, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. **Second**, there must be a **reasonable expectation of success**. **Finally**, the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).*

"The fact that references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references." *Ex parte Levengood, 28 USPQ2d 1300 (Bd. Pat. App.*

& Inter. 1993).

Examiners Arguments

Examiner argues "Neither the claim language not the record precludes reading the claims onto the structure of Tamaru. Tamaru may be regarded as disclosing metal filled contact openings which are not wiring grooves insomuch as the instant application, though a metal opening could also be called wiring".

Applicants respectfully note that such statement is not understandable. Applicants respectfully request a clear explanation of Examiners reasoning and support for his reasoning in the MPEP. Applicants respectfully request and explanation of how it is that Applicants claim language including readily understandable terms of art including contact layers, contact openings and contact holes may be interpreted contrary to the understanding of one of ordinary skill in the art as well as ignoring Applicants claim language that **explicitly excludes wiring grooves not in a contact layer** of the prior art (Tamaru).

Applicants have nevertheless further amended their claims in

a further effort to clearly and unambiguously define over the prior art, and have included the reference "Semiconductor Manufacturing Technology", M. Quirk, J. Serda, Prentice Hall, 2001, as further evidence of how one of ordinary skill in the art would interpret Applicants claim language including a **contact** structure, which includes the Applicants **contact** layers, **contact** openings and **contact** holes.

Conclusion

The cited references, singly or in combination fail to produce or suggest the elements of Applicants invention, and therefore fail to make out a *prima facie* case of obviousness.

Applicants have further amended their claims to further define over the prior art. Applicants respectfully request favorable reconsideration of their claims.

Based on the foregoing, Applicants respectfully submit that Applicants Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants= representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

Tung & Associates

Randy W. Tung
Reg. No. 31,311
Telephone: (248) 540-4040